Diagnosis

Diagnosis

Some children experience severe and life-interfering exacerbations separated by long periods of normal lung function and no symptoms. Any child with asthma can experience a life-threatening episode.

How do you diagnose asthma in children?

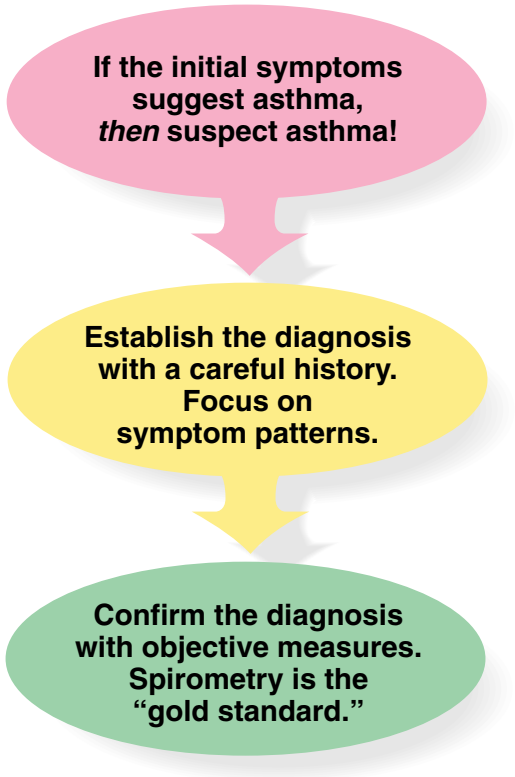
The clinician must determine that:

- Episodic symptoms of airflow obstruction (coughing, wheezing, shortness of breath or rapid breathing, chest tightness) are present.
- Airflow limitation is at least partially reversible.
- Alternative diagnoses are excluded.

Note:

- Signs and symptoms of asthma can vary widely and may mimic other common childhood illnesses. Diagnosis can be difficult and has important implications.
  - ⇒ On the one hand, asthma is frequently underdiagnosed and, thus, many infants and young children do not receive adequate therapy.
  - ⇒ On the other hand, not all wheeze and cough are caused by asthma, and caution is needed to avoid giving infants and young children inappropriately prolonged asthma therapy.
- Recurrent episodes of cough with or without wheezing are almost always due to asthma.
- Coughing may be the only symptom present.

Diagnosing the Child with Asthma



Diagnosis of children who wheeze with respiratory infections can be difficult.

- Underdiagnosis of asthma is a frequent problem, especially in children who wheeze when they have respiratory infections.
  - ⇒ These children are often labeled as having bronchitis, bronchiolitis, or pneumonia.
- Infants and young children (< 6 years) often wheeze with viral upper respiratory infections (URIs), and may benefit from asthma treatment.

Infants with indications of allergy (eczema, chronic rhinitis, positive skin tests) are more likely to wheeze throughout childhood, and may be at risk for asthma even without early symptoms. For most nonallergic infants, the wheezing lessens and ultimately disappears in the preschool years.

Consider asthma in children with repeated diagnoses of:

- Reactive airway disease
- Allergic bronchitis
- Wheezy bronchitis
- Asthmatic bronchitis
- Recurrent pneumonia
- Recurrent bronchiolitis

Less Common Masqueraders of Asthma in Children

- Upper airway noise/congestion
- Cystic fibrosis
- Tracheoesophageal fistula, gastroesophageal reflux
- Bronchopulmonary dysplasia
- Foreign body aspiration
- Vascular ring
- Primary immunodeficiency
- Congenital heart disease
- Vocal cord dysfunction

In early childhood, asthma is often misdiagnosed. Many infants and young children do not receive appropriate therapy.

Consider that in children…

- Wheezing does not always mean asthma.
- Asthma may be present without wheeze.

Signs and symptoms suggesting that the child does NOT have asthma:

- Failure to thrive
- Cyanosis at feeding
- Vomiting at feeding
- Failure to respond to appropriate treatment
- Clubbing

Consider alternate diagnoses!

Three Steps for Diagnosing Asthma in Children

1 Medical History

Ask the parents and/or child about:

- **Family history of allergy and asthma.**
- **Child's symptoms (coughing, wheezing, shortness of breath or rapid breathing, chest tightness).**
  - ⇒ When do symptoms occur?
  - ⇒ What causes symptoms?
  - ⇒ What makes symptoms worse?
- **Frequency and severity of the child's symptoms.**
  - ⇒ Do symptoms interfere with daily activities?
  - ⇒ Do symptoms limit physical activity?
  - ⇒ Do symptoms interfere with sleep?
  - ⇒ Do symptoms interfere with school performance or activities?
  - ⇒ Has the child needed to go to the emergency room or hospital?
- **Medications the child is using.**
  - ⇒ How many doses of short-acting bronchodilator is the child using? Daily? Weekly?

2 Physical Examination

Wheezing (during normal breathing or during prolonged forced exhalation) may or may not be present. Other physical findings that increase the probability of asthma include:

- Hyperexpansion of the thorax, use of accessory muscles, tachypnea.
- Presence of other allergic diseases (atopic dermatitis/eczema, swelling of and/or pale nasal mucosa, clear nasal discharge).

3 Objective Measurements

Consider asthma if ANY indicators from the history and physical examination are present. Confirm with objective measures of pulmonary function (if possible).

- **Spirometry is recommended to establish a diagnosis of asthma, but may not be feasible in young children (particularly under age 4 years).**

  ⇒ Some children cannot conduct the maneuver adequately until after age 7. For these children, clinical judgment and/or response to asthma treatment may be the only reliable means for diagnosing asthma.

When is it asthma?

History of recurrent:

- Coughing
- Wheezing
- Shortness of breath or rapid breathing
- Chest tightness

Symptoms made worse by:

- Viral infection
- Tobacco smoke, wood smoke, and other irritants (e.g., strong odors or fumes)
- Exercise
- Allergens (e.g., house-dust mites, pollens, cockroaches, molds, animal dander)
- Changes in weather/humidity
- Crying, laughing

Symptoms occur/worsen at night, waking the child and/or parent.

Reversible airflow limitation by spirometry in children over age 4 years and diurnal variation in peak flow.

- Wheezing (high-pitched whistling sounds when exhaling) may or may not be present.

No single indicator is diagnostic in itself, but the presence of several increases the probability of asthma. **OBJECTIVE MEASURES ARE ESSENTIAL TO ESTABLISH THE DIAGNOSIS OF ASTHMA.** For children < 4 years, or who cannot conduct spirometry, clinical judgment and/or response to asthma treatment may be the only reliable means for diagnosing asthma.

Symptom patterns are important. For children, consider:

WHEN do symptoms occur?

- At night, early morning?
- During/after exercise?
- Seasonally?
- After laughing, crying?
- Upon exposure to possible asthma triggers at home, school, daycare?

HOW SEVERE are symptom episodes?

- Absences from school, daily activities?
- Phone calls to the doctor?
- Unscheduled doctor visits?
- Emergency room visits?
- Hospitalizations?

Consider these characteristics of the child's home:

- Age
- Location
- Cooling and heating systems
- Wood-burning stove or fireplace
- Tobacco smoke
- Pets
- Humidifier
- Carpeting over concrete
- Presence of molds or mildew
- Characteristics of rooms where child spends time (e.g., bedroom, living room) with attention to bedding, floor coverings, stuffed furniture, toys

The child's medical history should include:

1. Symptoms

- Cough
- Wheezing
- Shortness of breath or rapid breathing
- Chest tightness

2. Symptom patterns

- Perennial, seasonal, or both
- Continual, episodic, or both
- Onset, duration, frequency (number of days or nights, per week or month)
- Diurnal variations, especially nocturnal and on awakening in early morning
- Exercise-induced cough or shortness of breath

3. Precipitating and/or aggravating factors

- Viral upper respiratory infections
- Environmental allergens: indoor at home, school, daycare (e.g., mold, dust mite, cockroach, animal dander or secretory products) and outdoors (e.g., pollen)
- Exercise
- Environmental change (e.g., moving to new home, going on vacation)
- Irritants: indoor at home, school, daycare (e.g., tobacco smoke, strong odors or fumes from cleaning agents, perfumes, or sprays, air pollutants) and outdoor (e.g., smog)
- Emotional expressions (e.g., fear, anger, frustration, hard crying, or laughing)
- Drugs (e.g., aspirin, noncorticosteroidal anti-inflammatory drugs, others)
- Food, food additives and preservatives (e.g., sulfites)
- Changes in weather, humidity, temperature
- Exposure to cold air
- Endocrine factors (e.g., menses)
- For older children, consider employment and characteristics of work environment, smoking, and use of drugs

4. Development of disease and current treatment

- Age of onset and diagnosis
- History of early-life injury to airways (e.g., bronchopulmonary dysplasia, pneumonia, parental smoking)
- Comorbid conditions (e.g., rhinitis, sinusitis, eczema)
- Family history of asthma, allergy, sinusitis, rhinitis, or nasal polyps in close relatives
- Progress of disease (better or worse)
- Profile of a typical exacerbation
- Present management and response, including plans for managing exacerbations, need for oral corticosteroids (and frequency of use)

5. Impact of asthma on child and family

- Episodes of unscheduled care (acute care, emergency department, urgent care, hospitalization)
- Life-threatening exacerbations (e.g., intubation, intensive care unit admission)
- Number of days missed from school or other activities
- Interruption of school/work due to asthma symptoms
- Activity limitations, especially sports and other physical activities
- History of nighttime awakening with symptoms
- Effect on growth, development, behavior, school performance
- Impact on family routines, activities, or dynamics
- Economic impact
- Daycare and school characteristics that may interfere with adherence to treatment

6. The child's and family's perceptions of disease

- Child and parent perception and beliefs about asthma and medications to treat asthma
- Ability of child and parents to cope with disease, and to recognize the severity of an asthma episode

---

This list does not represent a standardized assessment or diagnostic instrument. The validity and reliability of this list have not been assessed.

ADOLESCENTS may be more aware of their asthma symptoms than are younger children, but they may underestimate the severity of their symptoms. They may not want to admit that symptoms are interfering with daily activities.

Objective Measurements for Diagnosing Asthma in Children

Office-based physicians who care for asthma patients should have access to spirometry for diagnosis and for periodic monitoring.

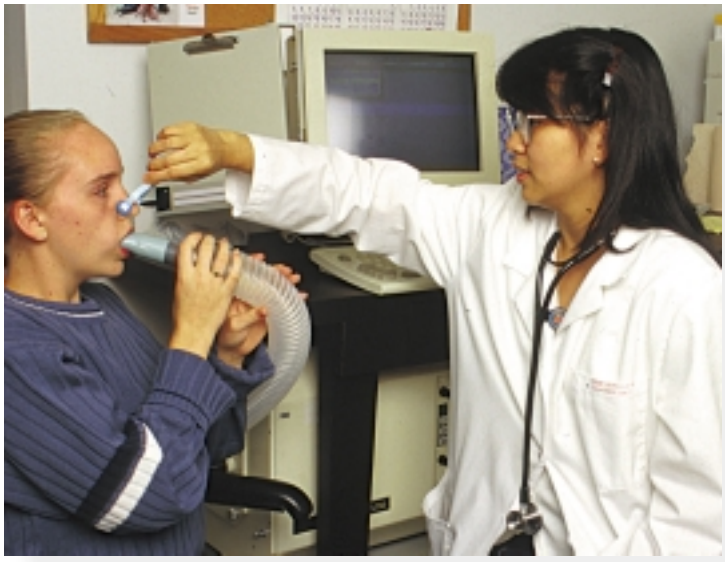
Spirometry (FEV_1, FVC, FEV_1/FVC) is preferred, and physicians caring for asthma patients should have access to it.

Spirometry before and 15-20 minutes after the child inhales a short-acting bronchodilator will help determine whether airflow obstruction is present, and if so, whether it is reversible with bronchodilator.

- **Airflow obstruction** is indicated by reduced FEV_1 and FEV_1/FVC values relative to reference or predicted values.
- **Significant reversibility** is indicated by an increase of at least 12% AND 200 mL in FEV_1 after inhaling a short-acting bronchodilator. (See page 41.)
  - ⇒ Occasionally, a short (3- to 10-day) course of oral corticosteroid therapy may be required to demonstrate reversibility.
  - ⇒ See page 41 for further explanation.

When measuring spirometry:

- **Use equipment and techniques** that meet the American Thoracic Society (1995) standards.
- **Use standardized norms that match the child's age and racial group.**



Monitoring peak expiratory flow (PEF) variability for 1 to 2 weeks is recommended:

- When the child has asthma symptoms, but spirometry is normal.
- To assess disease severity.
- To guide treatment or medication needs.

For diagnosis, spirometry is generally recommended over PEF in the clinician's office because:

- PEF is primarily a measurement of large airway function.
- Published PEF reference values vary widely, and according to brand of meter.
- Peak flow meters are designed as **monitoring** tools; they lack the sensitivity for diagnostic use.

Two ways to use a peak flow meter for long-term monitoring:

- Use every morning when the child wakes up, and before the child uses any medication.
  ⇒ Compare to the child's personal best PEF.

OR

- Use in the morning AND in the late afternoon or evening.
  ⇒ The evening measurement may be done after the child uses a short-acting bronchodilator (if the child uses a short-acting bronchodilator).
  ⇒ A greater than 20% difference between the morning and evening measurements suggests inadequately controlled asthma.

Some children cannot perform spirometry.

In this group, a trial with an inhaled $beta_2$-agonist and/or a short (3- to 10-day) course of oral corticosteroid may help aid and/or confirm the diagnosis.

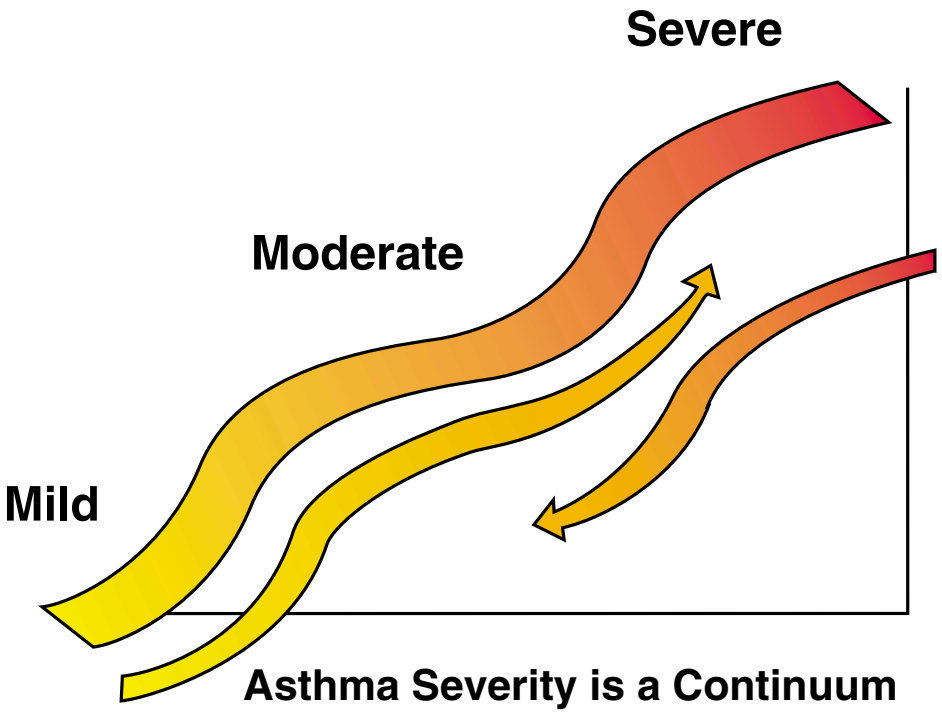
Classifying Asthma Severity in Children

- For any child with asthma, the severity of the disease can change over time.
- Any child with asthma may have a severe exacerbation.
  - ⇒ Classifying a child as having “mild asthma” (either intermittent or persistent) does not rule out the possibility of a severe exacerbation.
  - ⇒ Children with viral-induced wheezing may have severe episodes with complete resolution between episodes, and may remain symptom free for months.
- Children with more than 2 episodes of asthma symptoms per week have persistent asthma.

Asthma severity is a continuum.

Persistent asthma may become more severe or less severe over time.

Symptom exacerbations (“asthma attacks”) may be relatively mild or very severe, regardless of the severity of the child’s asthma.



How do you classify the child's asthma severity?

1. **BEFORE THERAPY** is started, classify severity according to the clinical features of the child's asthma.

Clinical Features of Asthma before Treatment:

It is not unusual for the clinical features of asthma to overlap. Assign classification by the most severe step in which any feature occurs.

			For children > 5 yrs who can use a spirometer or peak flow meter	
Classification	**Days with symptoms**	**Nights with symptoms**	**FEV_1 or PEF (% predicted normal)**	**PEF Variability**
Severe persistent	Continual	Frequent	≤ 60%	> 30%
Moderate persistent	Daily	≥ 5/month	> 60% to < 80%	> 30%
Mild persistent	> 2/week	3 to 4/month	≥ 80%	20% to 30%
Mild intermittent	≤ 2/week	≤ 2/month	≥ 80%	< 20%

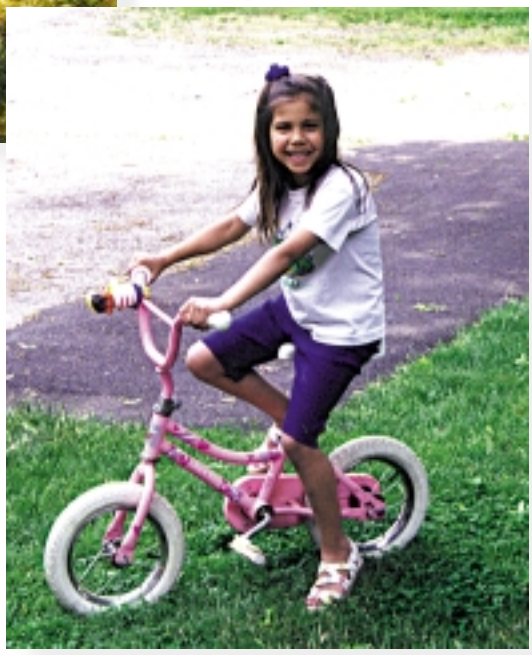
2. **BEFORE OPTIMAL THERAPY IS ATTAINED** (i.e. the child is taking medication but optimal control of the child's asthma has not yet been achieved), classify severity according to the clinical features of the child's asthma, as indicated in the aforementioned chart.

3. **AFTER OPTIMAL THERAPY IS ATTAINED**, the child's asthma severity can be classified according to the level of treatment needed to maintain control. For example:

- For **mild intermittent asthma**, no daily medication is needed. However, the use of short-acting beta$_2$-agonist more than 2 times per week may indicate the need to start long-term control medication.*
- For **mild persistent asthma**, one daily long-term control medication is necessary.*
- For **moderate persistent asthma**, inhaled corticosteroids with or without additional long-term control medications are indicated.*
- For **severe persistent asthma**, multiple long-term control medications are required, including high-dose inhaled corticosteroids and, if needed, oral corticosteroids.*

---

*See pages 68 to 76 for discussion of recommended medications.



Children with asthma may need additional tests to aid and/or confirm the diagnosis.

Reasons for additional tests	Suggested tests
Child has symptoms (coughing, wheezing, breathlessness, chest tightness), but spirometry is (near) normal	• Assess diurnal variation of PEF over 1-2 weeks • Bronchoprovocation with histamine, methacholine, or exercise (if negative, may rule out asthma)[1]
Suspect other factors are contributing to severity of asthma symptoms	• Nasal examination • Allergy tests, gastroesophageal reflux tests, sinus radiology[1]
Symptoms suggest infection, large airway lesions, heart disease, or obstruction by foreign object	• Routine chest x-ray, CAT scan[1]
Suspect co-existing chronic obstructive pulmonary disease or restrictive defect	• Additional pulmonary function tests; diffusing capacity test[1]

[1]Referral to a specialist is recommended for consultation or co-management.

Should the child be tested for allergies?

- Most children with asthma are allergic, but the specific allergy may not be obvious to the family or the physician.
- Review the child's exposure to allergens.
- Allergy testing is recommended for children with persistent asthma who are exposed to perennial indoor allergens.
- Allergy testing is helpful for diagnosing relevant allergic factors that may contribute to asthma severity. This will help identify and prioritize recommendations for controlling exposure to allergens. (Consider referral to or consultation with an asthma specialist.)

References

Ahlstedt S, Peterson CG, Enander I. Update in allergy testing in childhood asthma: how do you know whether you are successfully controlling the patient's inflammation? Pediatr Pulmonol 1995; 11:32-33.

American Thoracic Society. Lung function testing: selection of reference values and interpretive strategies. Am Rev Respir Dis 1991; 144:1202-1218.

American Thoracic Society. Standardization of spirometry: 1994 update. Am J Respir Crit Care Med 1995; 152:1107-1136.

Bye MR, Kerstein D, Barsh E. The importance of spirometry in the assessment of childhood asthma. Am J Dis Child 1992; 146:977-978.

Christopher KL, Wood RP II, Eckert RC, et al. Vocal cord dysfunction presenting as asthma. N Engl J Med 1983; 308:1566-1570.

Clough JB, Sly PD. Association between lower respiratory tract symptoms and falls in peak expiratory flow in children. Eur Resp J 1995; 8:718-722.

Coultas DB, Gong H Jr, Grad R, et al. Respiratory disease in minorities of the United States. Am J Respir Crit Care Med 1994; 149:S93-S131.

Coultas DB, Howard CA, Skipper BJ, Samet JM. Spirometric prediction equations for Hispanic children and adults in New Mexico. Am Rev Respir Dis 1988; 138:1386-1392.

Crapo RO, Lockey J, Aldrich V, Jensen RL, Elliott CG. Normal spirometric values in healthy American Indians. J Occup Med 1988; 30:556-560.

Enright PL, Lebowitz MD, Cockroft DW. Physiologic measures: pulmonary function tests. Asthma outcome. Am J Respir Crit Care Med 1994; 149:S9-S18.

Hankinson JL, Wagner GR. Medical screening using periodic spirometry for detection of chronic lung disease. J Occup Med 1993; 8:353-361.

Harding SM, Richter JE. Gastroesophageal reflux disease and asthma. Semin Gastrointest Dis 1992; 3:139-150.

Hegewald MJ, Crapo RO, Jensen RL. Intraindividual peak flow variability. Chest 1995; 107:156-161.

Hsu KH, Jenkins DE, Hsi BP, et al. Ventilatory functions of normal children and young adults - Mexican American, white, and black. Spirometry. J Pediatr 1979; 95:14-23.

Jackson AC. Accuracy, reproducibility, and variability of portable peak flow meters. Chest 1995; 107:648-651.

Klein RB, Fritz GK, Yeung A, McQuaid EL, Mansell A. Spirometric patterns in childhood asthma: peak flow compared with other indices. Pediatr Pulmonol 1995; 20:372-379.

Knudson RJ, Lebowitz MD, Holberg CJ, Burrows B. Changes in the normal maximal expiratory flow-volume curve with growth and aging. Am Rev Respir Dis 1983; 127:725-734.

Li JT, O'Connell EJ. Clinical evaluation of asthma. Ann Allergy Asthma Immunol 1996; 76:1-13.

Linna O. Spirometry, bronchodilator test or symptom scoring for the assessment of childhood asthma. Acta Paediatrica 1996; 85:564-569.

Malfroot A, Dab I. Pathophysiology and mechanisms of gastroesophageal reflux in childhood asthma. Pediatr Pulmonol 1995; 11:55-56.

Martin ME, Grunstein MM, Larsen GL. The relationship of gastroesophageal reflux to nocturnal wheezing in children with asthma. Ann Allergy 1982; 49:318-22.

Martinati LC, Boner AL. Clinical diagnosis of wheezing in early childhood. Allergy 1995; 50:701-710.

Miles JF, Bright P, Ayres JG, Cayton RM, Miller MR. The performance of Mini Wright peak flow meters after prolonged use. Respir Med 1995; 89:603-605.

Miller MR, Dickinson SA. Hitchings DJ. The accuracy of portable peak flow meters. Thorax 1992; 47:904-909.

Murray AB, Ferguson AC, Morrison BJ. Diagnosis of house dust mite allergy in asthmatic children: what constitutes a positive history. J Allergy Clin Immunol 1983; 71:21-28.

Murray AB, Milner RA. The accuracy of features in the clinical history for predicting atopic sensitization to airborne allergens in children. J Allergy Clin Immunol 1995; 96:588-596.

Nelson HS. Gastroesophageal reflux and pulmonary disease. J Allergy Clin Immunol 1984; 73:547-556.

Newman KB, Mason UG III, Schmaling KB. Clinical features of vocal cord dysfunction. Am J Respir Crit Care Med 1995; 152:1382-1386.

Orenstein SR. Management of GER in childhood asthma. Pediatr Pulmonol 1995; 11:57-58.

Quackenboss JJ, Lebowitz MD, Krzyzanowski M. The normal range of diurnal changes in peak expiratory flow rates. Relationship to symptoms and respiratory disease. Am Rev Respir Dis 1991; 143:323-330.

Rietveld S, Dooijes EH. Characteristics and diagnostic significance of wheezes during exercise-induced airway obstruction in children with asthma. Chest 1996; 110:624-631.

Russell NJ, Crichton NJ, Emerson PA, Morgan AD. Quantitative assessment of the value of spirometry. Thorax 1986; 41:360-363.

Shim CS, Williams MH Jr. Evaluation of the severity of asthma: patients versus physicians. Am J Med 1980; 68:11-13.

Shuttari MF. Asthma: diagnosis and management. Am Fam Physician 1995; 52:2225-2235.

Sly PD, Cahill P, Willet K, Burton P. Accuracy of mini peak flow meters in indicating changes in lung function in children with asthma. Brit Med J 1994; 308:572-574.

Spector SL, Nicklas RA. Practice parameters for the diagnosis and treatment of asthma. J Allergy Clin Immunol 1995; 96:729-731.

Struck RC, Mrazek DA, Wolfson Fuhrmann GS, LaBrecque JF. Physiologic and psychological characteristics associated with deaths due to asthma in childhood. A case-controlled study. J Am Med Assoc 1985; 254:1193-1198.

Struck RC. Asthma deaths in childhood: identification of patients at risk and intervention. J Allergy Clin Immunol 1987; 80:472-477.

Wald ER. Microbiology of acute and chronic sinusitis in children. J Allergy Clin Immunol 1992; 90:452-456.

Wall MA, Olson D, Bonn BA, Creelman T, Buist AS. Lung function in North American Indian children: reference standards for spirometry, maximal expiratory flow volume curves, and peak expiratory flow. Am Rev Respir Dis 1982; 125:158-162.

West JV, Robertson CF, Roberts R, et al. Evaluation of bronchial responsiveness to exercise in children as an objective measure of asthma in epidemiological surveys. Thorax 1996; 51:590-595.

Woolcock AJ, Colman MH, Blackburn CR. Factors affecting normal values for ventilatory lung function. Am Rev Respir Dis 1972; 106:692-709.